By consulting the table of verbal pronouns on the folder at the end of my *Preliminary report*, the reader will at once see the importance of the pronouns mentioned above, in determining the linguistic classification of Potawatomi. Complete tables for Potawatomi will be published in the *American Anthropologist*.

[1] *Amer. Anthrop., New York*, N. S., **6**, 369–411.
[2] *Smithsonian Inst., Rep. Bur. Amer. Eth.*, **28**, 221-290b.

THE LIGHT CURVE OF XX CYGNI AS A CONTRIBUTION TO THE STUDY OF CEPHEID VARIATION

By Harlow Shapley and Martha Betz Shapley

MOUNT WILSON SOLAR OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

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Probably as many as 90% of the 4500 stars whose light intensities are known to be variable may be placed in three well-defined classes. (1) The eclipsing variables are of various colors (or spectral types); their periods range from a few hours to a year or more in length, and their variation may be from less than one-tenth to several stellar magnitudes. (2) The long period variables are generally reddish stars; the cycle of their light-changes occupies from one hundred to six or seven hundred days, and the amount of their light variation is usually several magnitudes. (3) The largest class, however, since it includes the great number of variables in globular clusters and in other special regions of the sky, is that known as short period variables or Cepheid variables. Practically all types of spectra are represented, though types A and F predominate so far as now known. The periods in general are much less than 50 days, and for a very large subdivision (the cluster type variables) average about 12 hours. The variation, which is practically continuous, is nearly always of the order of one magnitude in range, and is characterized generally by a more rapid increase than decrease of brightness.

The cause and characteristics of eclipse variation are definitely known. But this can not be said of the other two main types of variable stars. Though many suggestions have been made, the true cause of long period variation remains more or less obscure. The interpretation of Cepheid variables has been much debated and much evidence in favor of various theories has been collected, but no explanation has as yet received general acceptance. The behavior of the spectral lines of Cepheids has led to the widely adopted assumption that they are spectroscopic binaries and that the light variations are in some way related to orbital

motion. But the many serious obstacles in the way of the double star hypothesis have been pointed out in a previous paper,[1] and the suggestion made that the observed facts may accord much better with the assumption that the light and velocity variations are both due to disturbances on a large scale of the radiating surfaces of single stellar bodies. Such periodic disturbances, which have in sun-spots a not very distant analogue both as to spectral displacements and light variations, would have as an underlying cause the long-enduring free oscillations that may be set up in a gaseous mass in a variety of ways, such as the collision with or close approach to another body, the perturbations by an obscure companion, or the adjustment of mass or temperature dissymmetries.

Among the arguments against the double star interpretation of Cepheids is their property of definitely changing color (therefore, of changing surface temperature) with the variation in the brightness of the star, thus indicating that the phenomenon is peculiar to the radiating surface and not merely geometrical as with the eclipsing double stars. Another point is the lack of regularity in the time of the principal phases and in the nature of the light variations. It is in connection with these two arguments that the present investigation hopes to contribute to the explanation of the Cepheid variables. In particular the present discussion of the light variations of the star XX Cygni challenges the frequently iterated assertion that the short period variable, because of its supposedly great precision and regularity of performance, is a veritable timepiece. In fact the suggestion is on record that the unit of time might possibly be based on the periodic return to maximum brightness of certain short period variables rather than on the rotation of the earth. While in most cases so far as now known the *mean* periods of such variables have, to be sure, but little or no secular or periodic variation, the study of XX Cygni, in agreement with preliminary results for similar variables, has shown definitely that the light curves change rapidly and, it may be, erratically both in time of maximum and in character of variation. The details of this work will appear in the *Astrophysical Journal*;[2] some of the chief results are outlined below.

In a monograph on the light variations of XX Cygni, Kron gives for the visual range 0.76 mag., based on the observations of seven observers, and for the photographic range, from observations by Parkhurst and Jordan, 0.63 mag.[3] This result is unusual in that the visual variation is the larger; every other variable star for which we have such information has a greater range photographically than visually. The difference between the ranges is a direct measure of the change in

color. That the star with the shortest known perod (3.2 hours) should show an abnormal color variation suggests that for some unknown reason it may be a real exception. To determine whether or not this is the case, observations were undertaken at Mount Wilson with the 60-inch reflector. Four series of plates were obtained (in all more than 300 exposures); each of the first two covers a complete period, and as Seed 27 plates were alternated with isochromatic plates (used with a yellow color filter), each series yields for the study of color phenomena complete, simultaneously determined photographic and photovisual light curves.

The photovisual curves thus obtained show no great deviation from Kron's mean visual curve. The ranges are 0.72 mag. and 0.85 mag., as compared with Kron's mean of 0.76 mag. The curves for the two nights differ in certain particulars from each other, and as both are smooth and well determined, the observed differences are probably real. This belief is supported by an investigation of the visual observations published by Kron, which show a much greater diversity in the shape of the nightly curves than can possibly be accounted for by errors of observation. There are, in general, two types of maximum; one is narrow and pointed, the other is broad, round-topped, and somewhat lower. The accompanying figure gives examples taken from the photometric observations by Guthnick at Berlin.

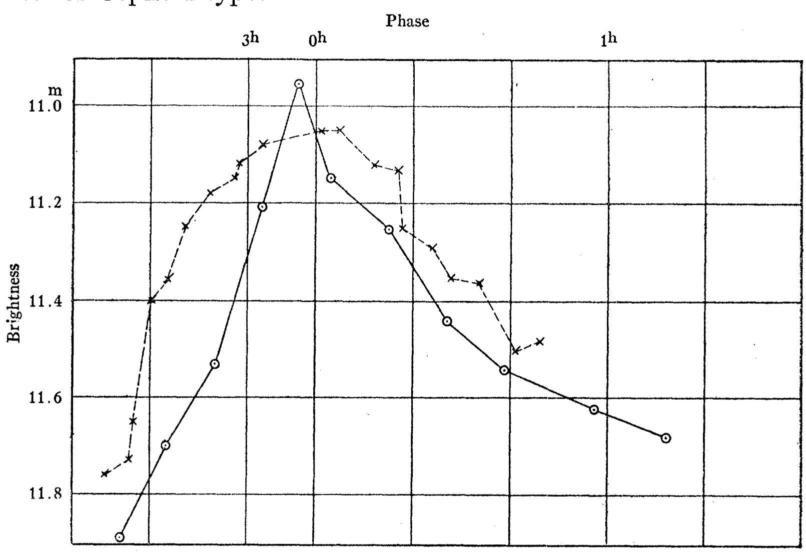
The Mount Wilson photographic curves differ from each other in the same way as the photovisual; for the same maximum the photographic and photovisual curves are very similar in form but differ from those of the other night.

A comparison of the Mount Wilson curves yields the following results: The photographic maximum occurs simultaneously with the photovisual within the errors of observation. The magnitudes at minimum phase agree for the two nights, being photovisually 12.17 and 12.17, and photographically 12.50 and 12.49, respectively. This gives a color index at minimum of +0.32, corresponding to spectral type A8 if the usual relation between color index and spectrum is adopted for this particular case. In the magnitudes at maximum, however, there is no such agreement. Photovisually they are 11.45 and 11.32, photographically 11.53 and 11.74, so that the color index at maximum varies from +0.08 to +0.42.

It is thus seen that so far as our data are decisive the photographic range is not constant. On one night it is 0.97 mag., on the other 0.75 mag. The smoothness and definiteness of the curves makes it impossible to attribute this large difference to observational errors entirely.

The constance of light at minimum and the evident variation at maximum leads to the conclusion that the minimum phase is the normal condition of the star, and suggests that the maxima represent fairly equally spaced but otherwise irregular and varied light disturbances.

As to whether the photographic or the visual range is the greater (the ratio of the two may not be constant), the data seem to indicate that the former is at least equal to the latter, if it does not, in fact, considerably exceed it, so that XX Cygni probably is not materially different in the matter of color change from other variables of the cluster or Cepheid type.



GUTHNICK'S VISUAL LIGHT CURVES OF XX CYGNI FOR SEPTEMBER 22, AND OCTOBER 5 (BROKEN LINE), 1908, SHOWING TWO EXTREME TYPES OF MAXIMUM.

Summary. (1) The cause of light variation has not been ascertained definitely for the variable stars known as Cepheids or short period variables, but in preference to the hypothesis that they are double stars an alternative explanation is proposed that seems to harmonize much better with observed data. (2) The new hypothesis would ascribe the periodic light and spectrum variations to vibrations in isolated stellar masses. (3) The present study of the variable XX Cygni is based upon 300 Mount Wilson photographic observations in which the variation for light of different wave-lengths is considered, and upon the analysis of 2700 visual measures by European astronomers. (4) It contributes to the solution of the problem by showing that a supposed exception to the normal color phenomena of Cepheids probably does not exist. (5) Of more importance to the Cepheid interpretation it

shows that the periodic occurrence of maximum, far from being clock-like in its precision, is distinctly irregular in phase and in other details.

[1] *Mt. Wilson Contr.* No. 92; *Astrophys. J.*, **40**, 448 (1914).

[2] A Study of the Light Curve of XX Cygni, *Mt. Wilson Contr.* No. 104; *Astrophys. J., in press* (1915).

[3] *Potsdam, Publ. Astrophysik. Obs.*, **22**, Part III (1912).

THE FEEBLY INHIBITED. III. INHERITANCE OF TEMPERAMENT; WITH SPECIAL REFERENCE TO TWINS AND SUICIDES

By C. B. Davenport

STATION FOR EXPERIMENTAL EVOLUTION, CARNEGIE INSTITUTION OF WASHINGTON

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Mood or emotional tone depends largely upon temperament; and temperament, it is commonly recognized, has a constitutional basis—is hereditary; the temperament is as little alterable as stature. However, there is a great diversity in temperaments; some persons are prevailingly gay; others prevailingly somber; and still others pass through alternating cycles of elation and depression. Of so complex a phenomenon the explanation cannot be simple. It must account for the following three states:

(*a*) the hyperkinetic state—i.e., a state of overactivity. Of this it will be convenient to distinguish two grades, a lesser and a greater. Following the terminology of an old psychology we may call the lesser grade of hyperkinesis *nervous*. The nervous person is active, energetic, irritable, excitable, ambitious, given to planning, optimistic; usually talkative and jolly. The greater grade of hyperkinesis is the choleric. A choleric person is apt to start a new line of work before he completes the old, brags, is usually hilarious, hyperotic, often profane, liable to fits of anger, brutal, destructive, assaultive, and even impulsively homicidal and suicidal.

(*b*) The opposite state is the hypokinetic or depressed. Here too we may distinguish two grades. The phlegmatic person is quiet, serious, conservative, pessimistic. The melancholic person is unresponsive (often mute), lachrymose, given to worry, weak and incapable, feels life a burden, often longs for death as a relief.

(*c*) The normal mood is shown in that the possessor is cheerful without being boisterous, calm, well balanced, and *en rapport* socially; he works and plays moderately, laughs quietly, does not weep easily, feels little drive, and is always responsive and coöperative. This